and 17, surrounding ~~the centrifuge~~ rotor by annular seals, 13 and 14, between 18 and bore 106 of housing 107. The concentrated carbon dioxide is removed through a volute 9, discharging at 110.

The enriched methane is removed through a port, 10, in the hollow shaft 2, and flows at 11 to another part 110 of the process. Wall 6 in the shaft separates flows 1 and 11. Auxiliary means to rotate the shaft is shown at 111.

Fig. 2 shows another centrifuge which can be used to decrease the concentration of carbon dioxide in a gas mixture.

A gas mixture 1', enters the centrifuge 100' via wall 110' and flows to a nozzle 2', which is oriented in a generally tangential direction to a cylindrical rotor 18'. The gas mixture is expanded in the nozzle to a high exit velocity at 3', in a direction generally tangential to the rotor. The gas flows through axial vanes 17', with turbine effect, which support the rotor from a shaft 16'. Nozzle 2' is radially offset relative to rotary shaft 16'. The rotor acquires the circumferential velocity component of the entering gas.

The heavier carbon dioxide is concentrated by the centrifugal force at centrifuge outer radius zone 4', near outer wall of the rotor 104. The lighter

methane is concentrated at the inner radius zone 5' near the surface of shaft 16' of the rotor. The concentrated carbon dioxide stream flows through outlet passage 7' increasing its pressure. The flow is then accelerated through a nozzle 8, adding more torque to the rotor to overcome windage and friction losses. The concentrated carbon dioxide stream is removed through a volute 9', discharging at 209'.

The concentrated methane stream flows into an outlet scoop 10', which faces in generally tangential relation to the circumferential flow direction to remove a produced and concentrated lighter gas such as methane, from the cylinder. The velocity is converted to pressure by the passage 11', which has an increasing flow area within wall 111' to diffuse the velocity and recover the velocity head as increased pressure at 12', and delivered at 300 to process 301. The concentrated methane is removed through another volute 12' at the outer side or end of 111'.

The rotor is supported by annular bearings 13' located between the shaft 16 and bores in end walls 110' and 111'. If sufficient pressure drop is available between 1' and 3', the shaft may be totally enclosed; otherwise, a seal is incorporated in the structure 13', and a power source 301 is provided to rotate the centrifuge at desired speed.

The pressure within the rotor 18' is isolated by annular seals 14 and 15 from the low pressure on the outer side 19' of the rotor, which is required to minimize frictional losses at the high speed of the rotor. The concentrated $CO_2$ in the volute 9', is isolated from the pressure within the rotor 18', and the pressure at zone 19' surrounding the rotor, by seals 14' and 15'.

Fig. 5 shows another centrifuge which can be used to decrease the concentration of carbon dioxide in a gas mixture.

A gas mixture ~~1'~~ 1'', enters the centrifuge ~~104'~~ 100'' via wall 110' and flows to a nozzle 2', which is oriented in a generally tangential direction relative to a cylindrical rotor ~~18'~~ 13''. The gas mixture is expanded in the nozzle to a high exit velocity at 3'', in a direction generally tangential to the cylindrical rotor. The gas flows through axial vanes 17'', with turbine effect, which support the rotor from a shaft ~~16'~~ 16''. Nozzle ~~2'~~ 2'' is radially offset relative to rotary shaft ~~16'~~ 16''. The rotor acquires the circumferential velocity component of the entering gas.

The heavier carbon dioxide is concentrated by the centrifugal force at centrifuge outer radius zone ~~4'~~ 4'', near outer wall 104'' of the rotor. The lighter methane is concentrated at the inner radius zone ~~5'~~

near the surface of shaft 16'' of the rotor. The concentrated heavier carbon dioxide stream flows through outlet passage 7'', increasing its pressure. The flow is then accelerated through a nozzle 8'', adding more torque to the rotor to overcome windage and friction losses. The concentrated carbon dioxide stream is removed through a volute 9'', discharging at 209'''.

The concentrated methane stream flows into another outlet passage 10'', whose inlet 10''' is located radially inward at the radial location 5'' where the lighter gas is concentrated. The concentrated methane stream flows through the outlet passage 10'' increasing it's pressure. The flow is then accelerated through a nozzle 8''' adding more torque to the rotor to overcome windage and friction posses. The concentrated methane is removed through another volute 9''' discharging at 209''.

The rotor is supported by annular bearings 13'' located between the shaft 16'' and bores in end walls 110'' and 111''.

The pressure within the rotor 18'' is isolated by annular seals 14'' and 15'' from the low pressure on the outer side 19'' of the rotor, which is required to minimize frictional losses at the high speed of the rotor. Such seals seal off between 18''

and wall 110a''. The concentrated $CO_2$ in the volute 9'', is isolated from the pressure within the rotor 18'' and the pressure at zone 19'' surrounding the rotor, by seals 14'' and 15''.

To further concentrate the carbon dioxide stream and the methane stream, the flows at ~~9'~~ 9'' and ~~12'~~ 2 ' leaving the centrifuge from Fig. 5, can be introduced to additional like centrifuges, i.e. a ''cascade'' of centrifuges.. The cascade provides a method of connecting many centrifuges together so as to amplify the separation capacity and flow rate of a single unit.

The cascade is typically comprised of a number of stages, the size of each stage being defined by the amount of flow that must go through the cascade. The amount of flow required is directly related to the desired flow of the product (the stream comprised mostly of the lighter gas) and its concentration. The desired concentration, in turn, determines the number of stages necessary. The product delivery end of the cascade is called the ''top'' while the waste end is called the ''bottom''.

The cascade is divided into two sections, the ''stripper'' and the ''enricher''. The enricher section is that between the feed point (where the mixture comes in) and the top of the cascade, while the stripper section is the section below the feed point.